CLAIMS

1. A micro-filtration device for sorting cells comprising:

an apparatus including a barrier structure defining an array of openings arranged within a fluid flow path, the openings having at least one of a size and a shape configured to direct only a portion of the cells through the openings based on at least one of a size and a shape of each cell; and

an electrode arrangement disposed about the array of openings and configured to apply an electric field to enhance direction of the portion of the cells through the openings.

2. The device of claim 1, wherein the electrode arrangement is separate from the array of openings.

3. The device of claim 1, wherein the electric field is a non-uniform electric field.

4. The device of claim 3, wherein the fluid flow path is configured to conduct cells in a first direction to move the cells through the apparatus and the electrode arrangement is arranged to generate the non-uniform electric field as a temporally varying non-uniform electric field in a second direction different from the first direction.

5. The device of claim 4, wherein the openings comprise:

a first set of openings permitting passage of cells of a first size in the first direction;

a second set of openings permitting passage of cells of a second size, smaller than the first size, in the first direction;

a third opening extending transversely between the first and second set of openings, and permitting movement of cells in the second direction; and

wherein the electrode arrangement comprises a first electrode array extending within the third opening and configured to apply the temporally varying non-uniform electric field to move cells of the first size in the second direction, which is transverse to the first direction of the fluid flow path, away from the first and second set of openings.

6. The device of claim 4, wherein the barrier structure comprises:

a plurality of barrier arrays aligned generally parallel to each other to define a succession of barrier arrays, each successive barrier array defining a smaller set of passages to progressively sort cells in decreasing size as the cells move in the fluid flow path in the first direction; and

a plurality of transport paths disposed between extended transversely to the successive barrier arrays with each transport path including an electrode array of the electrode arrangement, the electrode array configured to apply the temporally varying non-uniform electric field to move the portion of the cells through each respective transport path in the second direction.

7. The device of claim 3, wherein the openings have an elongate shape and the electrode arrangement is arranged to form the non-uniform electric field substantially aligned with the elongate shape of the openings.

8. The device of claim 7, wherein the array of openings comprises:

a first set of openings wherein the electrode arrangement straddles the first set of openings to apply the non-uniform electric field to substantially align a long axis of the cells with a long axis of the openings of the first set of openings.

9. The device of claim 8, wherein the electrode arrangement comprises:

a first pair of electrodes including a first electrode and a second electrode, the first electrode and the second electrode disposed on opposite sides of the first set of openings and configured to apply the non-uniform electric field.

10. The device of claim 9 wherein the first electrode is disposed above the first set of openings and the second electrode is disposed below the first set of openings to apply the non-uniform electric field as a first non-uniform electric field.

11. The device of claim 9, wherein the first electrode is disposed at an entrance of the first set of openings and the second electrode is disposed at an exit of the first set of openings to apply the non-uniform electric field as a second non-uniform electric field.

12. The device of claim 9, wherein the first electrode is disposed above the first set of openings and the second electrode is disposed below the first set of openings to apply the non-uniform electric field as a first non-uniform electric field; and wherein the electrode arrangement comprises:

a second pair of electrodes with a first electrode and a second electrode, wherein the first electrode of the second pair of electrodes is disposed adjacent an entrance of the first set of openings and the second electrode of the second pair of electrodes is disposed adjacent an exit of the first set of openings to apply the non-uniform electric field as a second non-uniform electric field.

13. The device of claim 1, further comprising:

at least one of an acoustic device and an electric device each configured to apply a force to the cells traveling along the fluid flow path to prevent aggregation of the cells within the apparatus.

14. A cell sorter chip comprising:

means for sorting cells based on a plurality of dimensions of the cells; and

means for electrically enhancing the sorting of cells.

15. The chip of claim 14, wherein the means for sorting cells comprises:

a substrate having a barrier structure defining openings.

16. The chip of claim 15, wherein the openings each have a long axis, and the means for electrically enhancing the sorting comprises an electrode array disposed and arranged to generate an electric field to align a long axis of the cells with the long axis of the openings.

17. The chip of claim 16 wherein the electric field is a non-uniform electric field.

18. The chip of claim 15, wherein the barrier structure defines an area of filtration on the substrate, wherein the means for electrically enhancing the sorting comprises an electrode array disposed and arranged to convey the cells away from the area of filtration.

19. The chip of claim 15, further comprising means for inducing a fluid flow in a first direction along a path of the fluid flow and through the openings, wherein the means for electrically enhancing the sorting is disposed for transporting the cells in a second direction to a location out of the fluid flow.

20. The chip of claim 19, wherein the means for electrically enhancing the sorting comprises an electrode array disposed and arranged to apply a temporally varying non-uniform electric field to transport a certain size range of cells from the fluid path.

21. The chip of claim 14, wherein the means for sorting and the means for electrically enhancing the sorting together comprise at least one of:

a first filtration device that sorts cells according to their sizes succeeded within a fluid flow path by a second filtration device that sorts cells according to their dimensional orientation; and

the second filtration device that sorts cells according to their dimensional orientation is succeeded within the fluid flow path by the first filtration device that sorts cells according to their sizes.

22. The chip of claim 21, wherein the means for electrically enhancing the sorting comprises:

a first electrode arrangement configured to apply a temporally varying non-uniform electric field in the first filtration device to move groups of cells, sorted according to their respective sizes, out of the first filtration device; and

a second electrode arrangement configured to apply an electric field in the second filtration device to permit cell passage within the second filtration device by causing at least one dimension of the cells to become aligned with a gap that has a shape and a size substantially matching the at least one dimension of the cells.

23. A method of sorting cells on a biodevice comprising:

directing a flow of cells within a fluid into a filtration structure defining an array of fluid openings; and

encouraging cell passage of each cell of a portion of the cells through the fluid openings based on at least one dimension of each cell via application of an electric field within the fluid openings.

24. The method of claim 23, wherein encouraging cell passage comprises:

aligning each cell in the portion of the cells relative to the fluid openings.

25. The method of claim 24, wherein the fluid openings include an elongate shape, each fluid opening has a major axis substantially perpendicular to a direction of fluid flow through the fluid openings and each cell has a major axis, and wherein aligning each cell comprises:

applying the electric field to align the major axis of each cell with the major axis of one of the fluid openings.

26. The method of claim 25, wherein each cell has two major axes and a minor axis.

27. The method of claim 24, wherein each cell has one major axis and a direction of passage through the fluid openings, wherein encouraging cell passage comprises:

aligning the major axis of each cell with the direction of passage through the fluid openings.

28. The method of claim 23, wherein directing the flow of cells comprises:

separating cells as the cells flow through successive arrays of openings with each array of openings having decreasing dimensions to sort the cells into different groups based on their size; and wherein encouraging cell passage comprises:

moving the different groups of cells in independent, generally parallel pathways in a direction generally transverse to the flow of cells through the array of fluid openings by application of the electric field as a temporally varying non-uniform electric field along each pathway.

29. The method of claim 23 wherein encouraging cell passage comprises:

applying the electric field as a non-uniform electric field.